

Missouri Corporation for
Science and Technology
1989 Annual Report



January 1, 1990

Governor John Ashcroft and
Members of the 86th General Assembly
State Capitol Building
Jefferson City, MO 65101

Dear Governor Ashcroft and Members of the 86th General Assembly:

The Missouri Corporation for Science and Technology is pleased to submit to you its 1989 annual report in accordance with RSMo. 348.255(1) Supp. 1983.

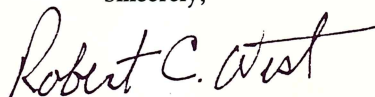
Significant advances occurred in Missouri's technology programs during 1989. This report will provide you with a comprehensive summary of the successes achieved in each of these programs.

The Centers for Advanced Technology are in full operation and have attracted the interest and support of significant private co-sponsors. The four Innovation Centers have each reached major milestones in client activity and new product development. The Higher Education Applied Projects fund has provided support for several new projects and continues to advance applied research across the state. The Seed Capital Program has been utilized this year by investors who assisted in funding a variety of early stage technology opportunities. The Small Business Innovation Research Program has provided an additional source of funding for many research projects undertaken by Missouri companies during 1989.

The state's research parks at Weldon Spring and Kansas City have been actively pursuing companies that are interested in locating within one of these two parks.

The Missouri Corporation for Science and Technology is proud to be a part of each of these expanding programs.

Sincerely,

A handwritten signature in dark ink, reading "Robert C. West". The signature is fluid and cursive, with a long horizontal stroke extending from the end of the name.

Robert C. West
Chairman





Robert C. West
Chairman

MEMBERS

Timothy J. Bennett

Income Development Corporation
Springfield, Missouri
Term Expires January 1991

Ruth R. Blake

President
Blake Development Co., Inc.
Kansas City, Missouri
Term Expires January 1990

Jerry M. Hunter

Director
Missouri Department of Labor and
Industrial Relations
Jefferson City, Missouri
Term Expires January 1990

Martin C. Jischke, Ph.D.

Chancellor
University of Missouri-Rolla
Rolla, Missouri
Term Expires January 1991

Dixie A. Kohn, Ph.D.

President
Mineral Area College
Flat River, Missouri
Term Expires January 1990

Marvin Marks

Retired-McDonnell Douglas
St. Louis, Missouri
Term Expires January 1990

James McKelvey, Ph.D.

Dean, School of Engineering and
Applied Science
Washington University
St. Louis, Missouri
Term Expires January 1990

Lowell Miller, Ph.D.

Marion Laboratories
Kansas City, Missouri
Term Expires January 1991

Roger L. Mitchell, Ph.D.

Dean, School of Agriculture
University of Missouri-Columbia
Columbia, Missouri
Term Expires January 1990

James C. Olson, Ph.D.

President Emeritus-UM
University of Missouri-Kansas City
Kansas City, Missouri
Term Expires January 1990

William D. Phillips, Ph.D.

Retired-Mallinckrodt, Inc.
St. Louis, Missouri
Term Expires January 1990

George A. Russell, Ph.D.

Chancellor
University of Missouri-Kansas City
Kansas City, Missouri
Term Expires January 1991

Robert Schutz

President of the Advanced Circuitry
Division of Litton Industries
Inter-Pak Electronics
Springfield, Missouri
Term Expires January 1990

George Sloan

Vice President
Research and Technology
St. Louis RCGA
St. Louis, Missouri
Term Expires January 1991

Tom Sowers

President
Tom Sowers Company
Rolla, Missouri
Term Expires January 1990

William Stacy, Ph.D.

President
Southeast Missouri State University
Cape Girardeau, Missouri
Term Expires January 1990

Duane Sunderman, Ph.D.

Midwest Research Institute
Kansas City, Missouri
Term Expires January 1992

Robert C. West

Chairman Emeritus
Sverdrup Corporation
St. Louis, Missouri
Term Expires January 1991

1989 OFFICERS

Chairman, Robert C. West
Vice-Chairman, George A. Russell, Ph.D.
Secretary/Treasurer, Jerry Hunter
Executive Director, Garry E. Taylor

COMMITTEES

EXECUTIVE COMMITTEE

Robert C. West, Chairman
George A. Russell, Ph.D.
Roger Mitchell, Ph.D.
William D. Phillips, Ph.D.
George Sloan
Ruth R. Blake
Martin Jischke, Ph.D.
Lowell D. Miller, Ph.D.

INNOVATION & RESEARCH COMMITTEE

William D. Phillips, Chairman
George Sloan
Roger Mitchell, Ph.D.
Duane Sunderman, Ph.D.
Marvin Marks

FINANCE COMMITTEE

Ruth R. Blake, Chairman
Jerry Hunter

POLICY & GOALS COMMITTEE

George A. Russell, Ph.D., Chairman
Marvin Marks
William Stacy, Ph.D.
James C. Olson, Ph.D.

EDUCATION COMMITTEE

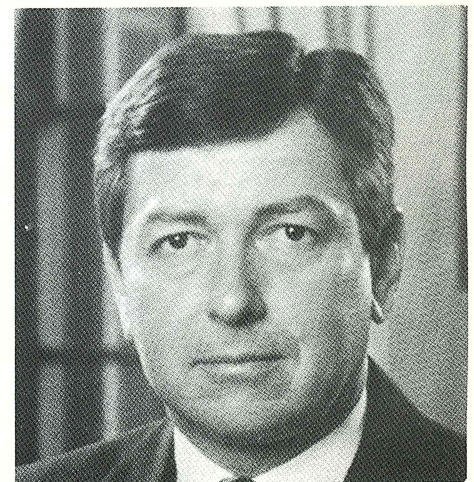
Martin Jischke, Ph.D., Chairman
James McKelvey, Ph.D.
Dixie Kohn, Ph.D.
Jerry Hunter
Lowell Miller, Ph.D.

CENTERS FOR ADVANCED TECHNOLOGY

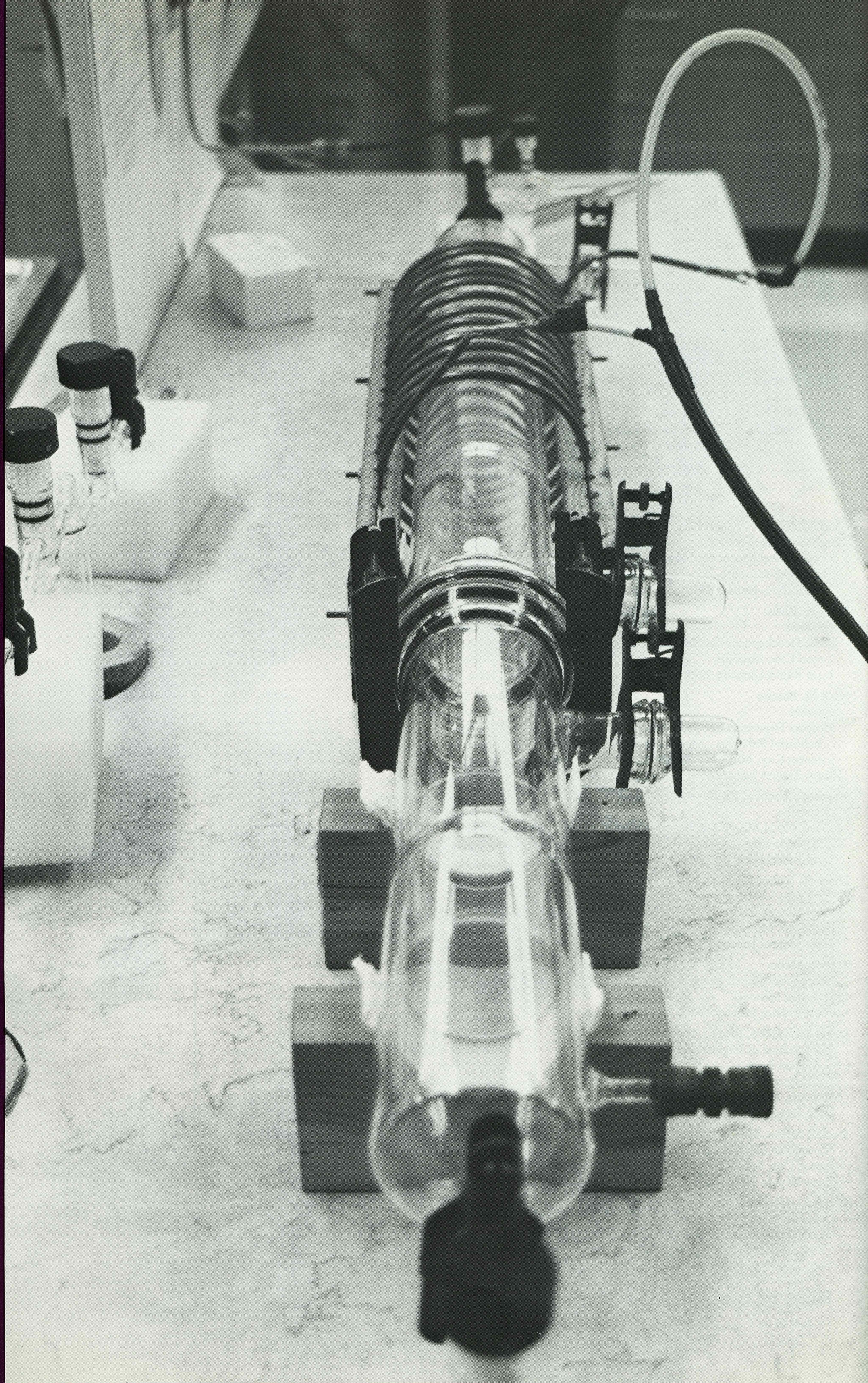
Marvin Marks, Chairman
Duane Sunderman, Ph.D.
William D. Phillips, Ph.D.
Lowell D. Miller, Ph.D.

HIGHER EDUCATION APPLIED PROJECTS

Ruth R. Blake, Chairman
Dixie Kohn, Ph.D.
Robert Schutz



John D. Ashcroft
Governor



History

The Missouri Corporation for Science and Technology, established in 1983, has as its exclusive purpose to contribute to the strengthening of the state's economy by fostering the development of science and technology. The Corporation emphasizes its goal of promoting the state's future economic growth by supporting and nurturing scientific research and advanced technology companies. Representative of Missouri's commitment to the future, the Corporation continues to advise the Governor and the Missouri Department of Economic Development on programs and initiatives which enhance the development of science and technology in the state.

Working with Missouri's universities and colleges, the Corporation continues to assist in meeting the research needs of private industry; to attract private and public sector investment for research and development; and to assist in the development of science education by participating in programs such as the Missouri Academy of Science annual poster presentation, and support for the Missouri Alliance for Science, Mathematics and Technology. These organizations provide support for science, mathematics and technology education at the elementary, secondary and post-secondary levels. Other educational activities include support of National Science and Technology week, which will be observed during the week of April 22, 1990 by the National Science Foundation.

Higher Education Applied Projects Fund

The Higher Education Applied Projects (HEAP) fund, established in 1982 through the Missouri Research Assistance Act, is a challenge grant competition with a maximum two-to-one, public-to-private dollar match for small businesses participating in the program. These projects focus on applied research conducted through any higher education institution in Missouri except the University of Missouri. The definition of an applied project is "any activity which seeks to utilize, synthesize, or apply existing knowledge, information, or resources to the resolution of a specified problem, question, or issue." In addition, the Missouri Research Assistance Act also provides funding for the Higher Education Research Fund administered by the University of Missouri Board of Curators for basic research conducted through the University of Missouri campuses, St. Louis

University or Washington University. This challenge grant competition provides a maximum two-to-one, private-to-public dollar match for small businesses, and a one-to-one match for large businesses.

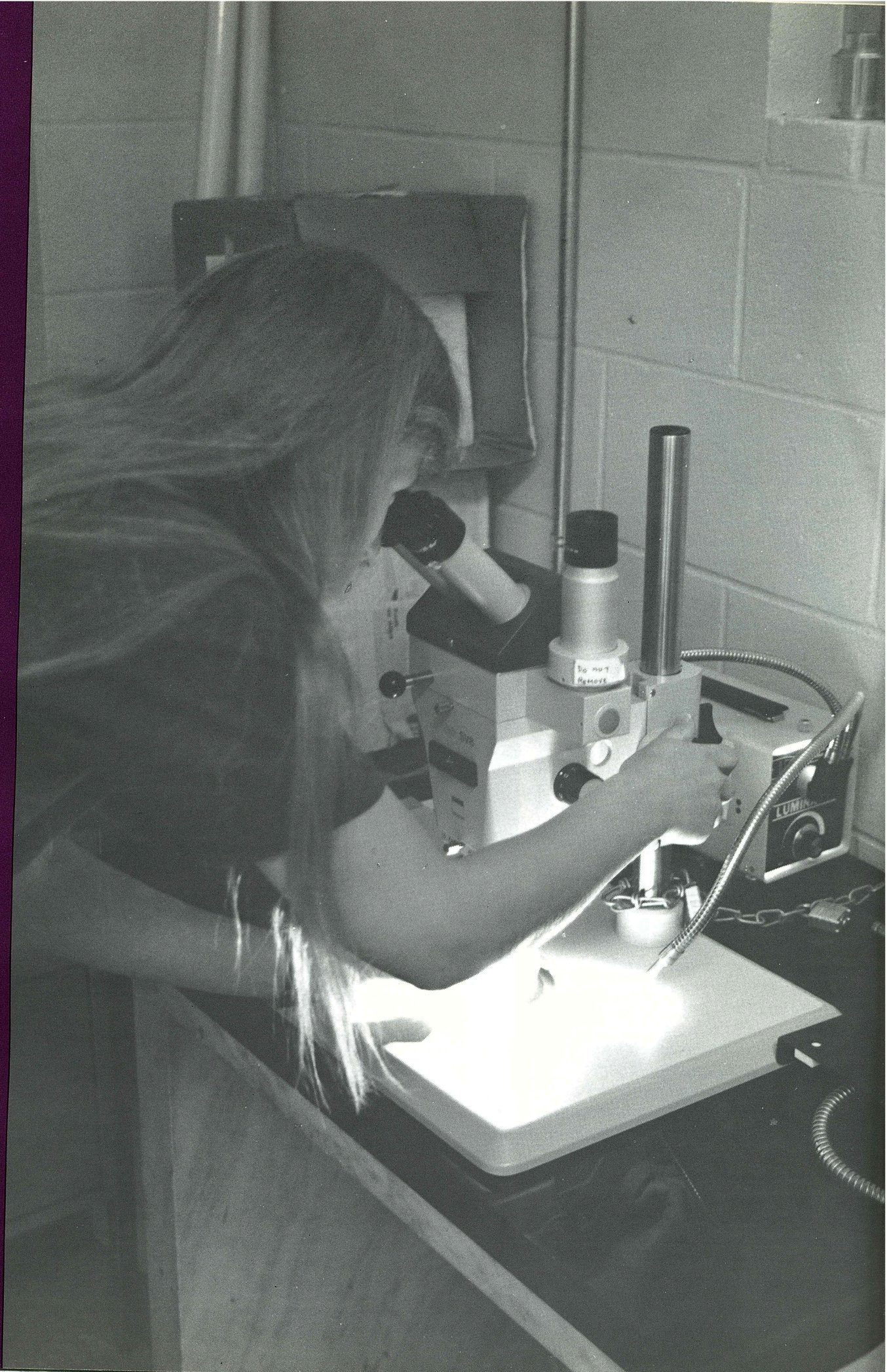
With the transfer of administration from the Coordinating Board for Higher Education to the Department of Economic Development, HEAP program guidelines were revised by the Fund Advisory Committee (FAC) in an effort to improve the quality of proposals received. The Applied Projects FAC is made up of members of the Corporation, the Missouri Department of Economic Development, and representatives of eligible higher education institutions. It is charged with the administration and review of the HEAP program. This committee reports directly to the Director of the Department of Economic Development. It is this committee that reviews each proposal and forwards funding recommendations to the Director for final decisions. The FAC established two annual

solicitation periods for the submission of proposals, January 1-February 15 and July 1-August 15.

In calendar year 1989, 7 grants were awarded to Missouri's higher education institutions and businesses, totaling \$203,053 with a private match of more than \$237,964.

The FAC conducts on-site reviews of those projects funded during the department's solicitation periods. The committee looks for tangible evidence that the funds are wisely and properly used in these applied research projects. Direct access to the intellectual and scientific resources of Missouri's eligible public/private higher education institutions, in combination with the needs of our existing businesses, will prove beneficial for both parties. The benefit to business is accelerated development of a new product, process or service at a reduced research and development cost.





Higher Education Applied Projects (HEAP)

1989

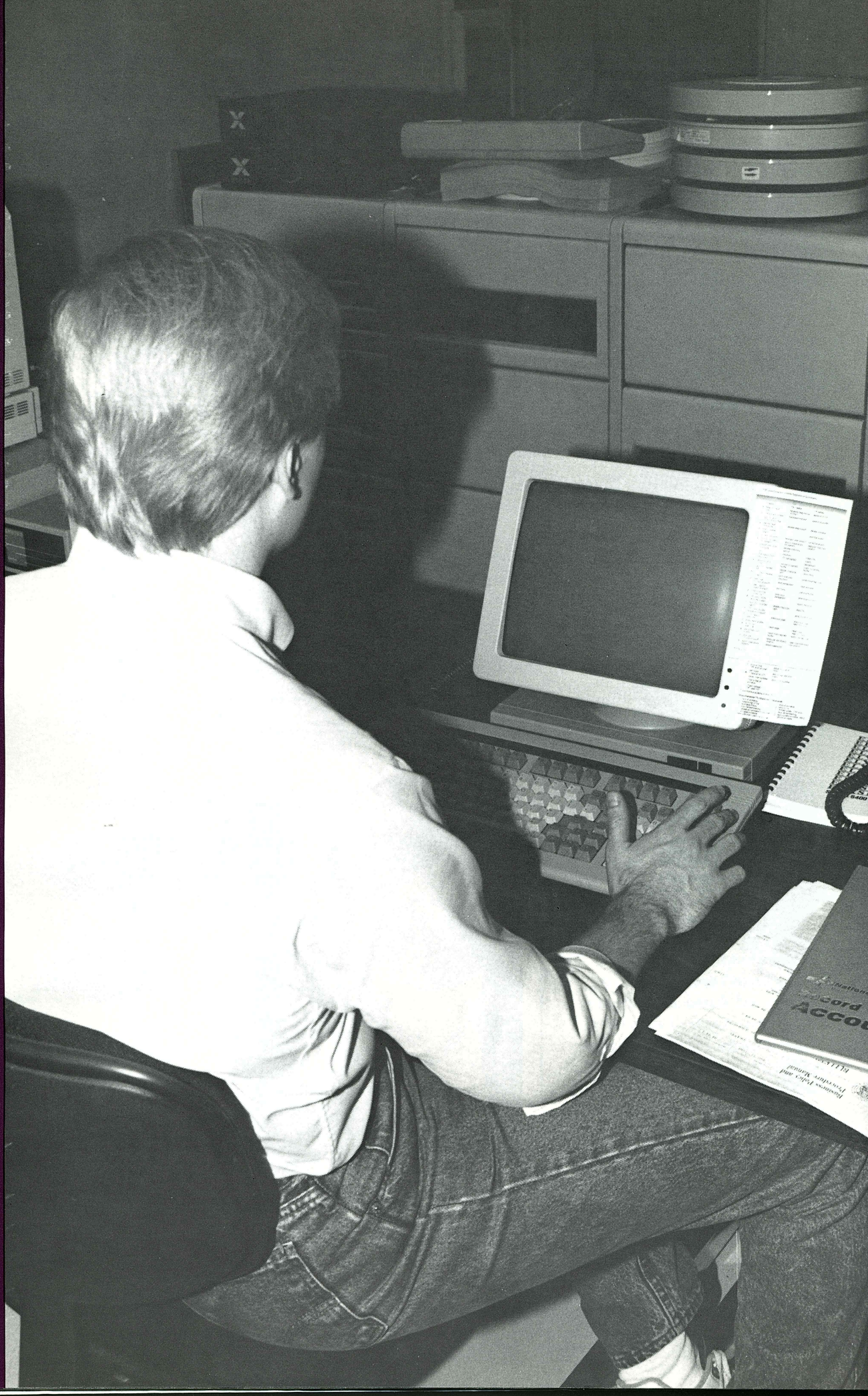
<i>Project</i>	<i>HEAP Match</i>	<i>Private Match</i>
Development and Evaluation of Recreational and Boat Trailer Guide Rails and Runners/ Southwest Missouri State University	\$ 11,100	\$ 33,740
Noise Pollution Reduction in Industrial Vacuums and Blowers/Central Missouri State University	\$ 35,000	\$ 33,595
Development of Advanced Polymeric Materials Process and High Performance Automotive Accessory Drive Pulleys/ Southwest Missouri State University	\$ 31,633	\$ 65,100
Advanced Photoresist Materials for Integrated Circuits Manufacturing/Southwest Missouri State University	\$ 16,100	\$ 11,500
Using Traces of Non-Radioactive Chemical Substances for Fast Oil-Consumption Measurements in Piston Engines During Continuous and Transient Operations/ Washington University	\$ 41,420	\$ 22,809
Implementation of a Transportation Management System/Central Missouri State University	\$ 47,800	\$ 41,220
Star II, A Solar Powered Vehicle/Crowder College	\$ 20,000	\$ 30,000
Totals	\$203,053	\$237,964

Innovation Centers

Entering their fifth year of operation, Missouri's four innovation centers, authorized by the Missouri Legislature, located in Columbia, Rolla, St. Louis and Kansas City, continue to create environments of support and assistance for innovators and entrepreneurs involved in various stages of bringing new products or processes to market. The centers provide low-cost physical space and shared administrative and clerical services as well as technical, managerial, financial and other assistance to new firms, with special emphasis given to the needs of firms in advanced technology areas.

Coordination of the four centers is one of the responsibilities of the Missouri Corporation for Science and Technology. The Corporation's Innovation and Research Committee oversees the centers' actions and plans and advises the Department of Economic Development on recommendations for the future innovation center operations.





The Center for Business Innovation, Incorporated— Kansas City, Missouri

The Center for Business Innovation (CBI) is governed by a Board of Directors comprised of 29 prominent business and community leaders, successful entrepreneurs, financiers and representatives from the University of Missouri-Kansas City (UMKC).

CBI assists start-up business ventures engaged in key technology areas such as basic life sciences, telecommunications and computer science, and innovative technological products and services by providing management, technical and financial assistance. Its policy is to provide "value-added" assistance to start up ventures through the provision of professional business services which can help to create a more valuable business. CBI provides office and laboratory space, as well as shared administrative and support services: receptionist and telephone answering, conference rooms, computer facilities, secretarial services, photocopier, fax and audio/visual equipment.

The management staff at CBI offers tenant companies (those housed at CBI) and client companies (those not residing at CBI) combined experience in the areas of start-up businesses, start-up financing, product development, sales, marketing, business management, accounting, education, engineering, business planning and financial planning. The management staff takes an active role in the development of business and strategic plans for tenants, and is involved in the implementation of specific aspects of the tenants' and clients' stated objectives for development and growth.

CBI is located on the campus of the UMKC. This locale enables CBI to link tenants and clients needing technological assistance in the University's areas of research expertise with the best resources at UMKC. CBI and UMKC have developed a cooperative partnership to advance the commercialization of technology from the University to the marketplace. CBI also works closely with UMKC's Henry W. Bloch School of Business and Public Administration.

CBI is situated within the area of the 68-acre University Park at Kansas City, which will become a \$300 million research park development designed to house new technology companies. Linda Hall Library, considered one of the finest scientific and

technical reference libraries in the world, is located a short distance from CBI. Missouri Research Institute is also located adjacent to this area.

During the fiscal year ended June 30, 1989, the Center for Business Innovation, its tenant and client companies, and its graduate tenant and client companies employed 170 people; total tenant/graduate/client revenues exceeded \$5.9 million with a total tenant/graduate/client payroll in excess of \$2.6 million. During the past year tenants and clients generated \$407,000 in debt financing, \$1,395,855 in equity financing, \$100,188 in royalties and grants, for a total of \$1,903,043 in tenant/client financing.

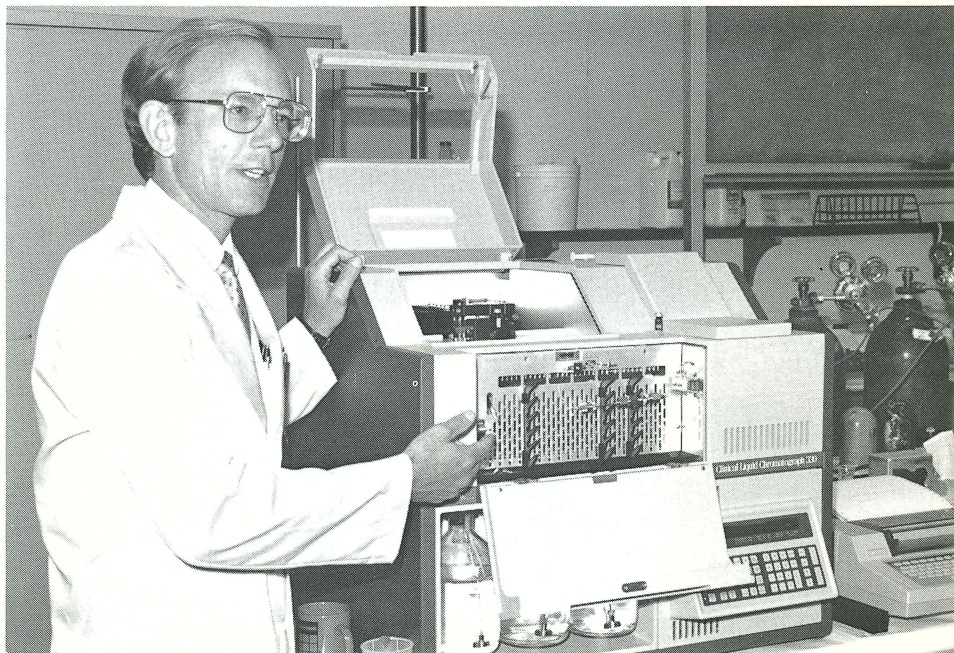
CBI is a founding member of and maintains a close relationship with the "Silicon Prairie Technology Association," established to serve area needs in technology education and information exchange, and to promote the Midwest as a growing technology center.

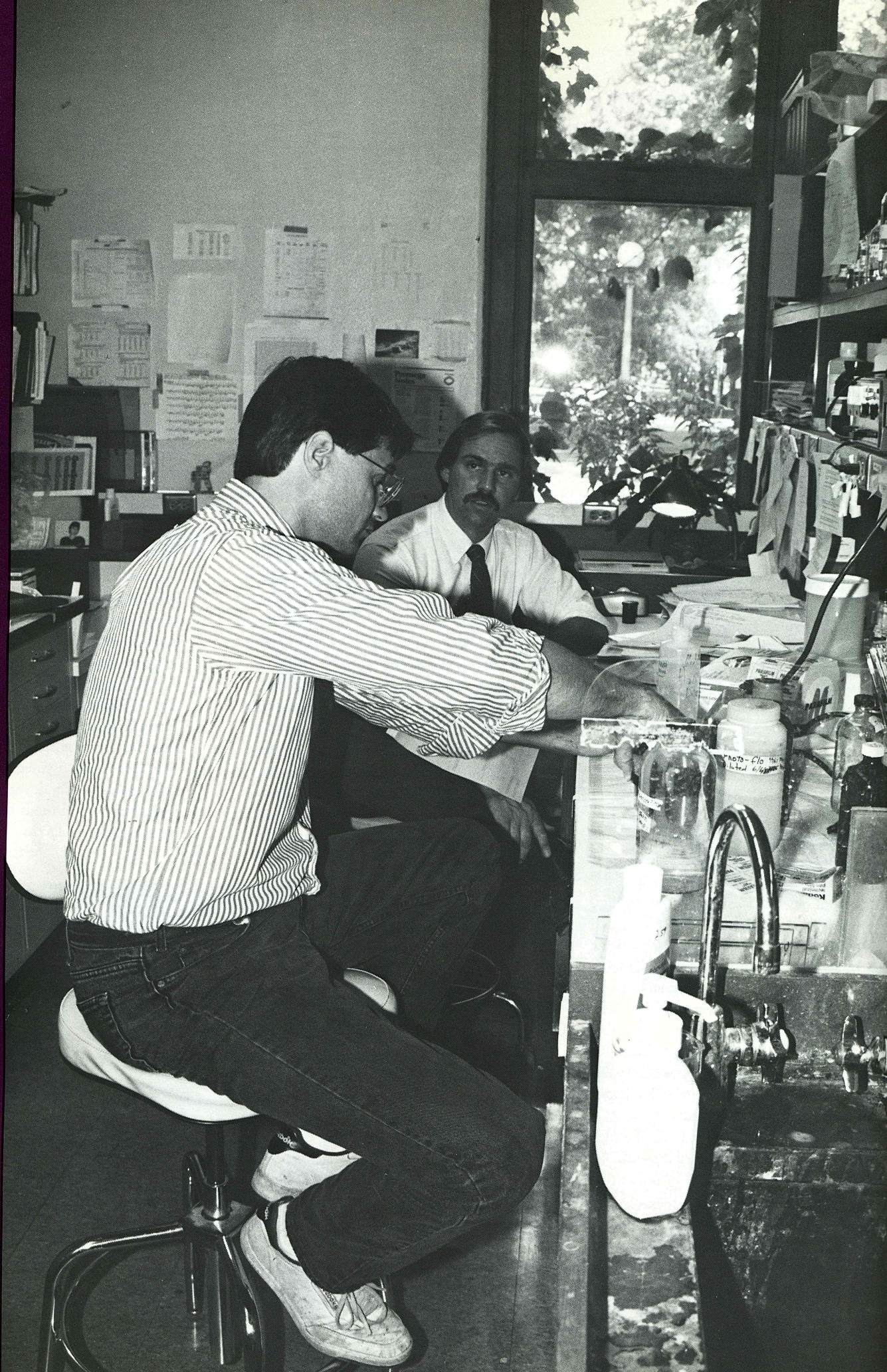
All of these activities support CBI's mission to create jobs, stimulate economic development within the state of Missouri, and create beneficial partnerships among entrepreneurs, universities, government and private investors.

The Center has been credited with assisting a diverse group of new business ventures in the Kansas City area. Most noteworthy is its assistance to the Primus Corporation and Radiant Systems, Incorporated. The Primus Corporation is involved in the development of automated clinical blood testing instrumentation based upon High-Performance Liquid

Chromatography, an advanced technique of chemical measurement. The initial application of the company's instrumentation will be improved blood testing, important in the management of diabetic therapy. Additional applications of the instrumentation are planned to improve clinical testing for a variety of compounds in blood and other body fluids. The UMKC Schools of Pharmacy and medicine are conducting the applications research. The Center assisted Primus Corporation in its successful \$258,000 common stock offering. The Center also assisted in negotiating the letter of intent Primus Corporation recently signed with the local branch of a venture capital company for an investment of \$1 million in the company's preferred stock. The Center also assisted Primus Corporation in obtaining a grant of over \$140,000. This grant was received through the Missouri Research Assistance Act (MRAA).

Radiant Systems, Inc. is developing a series of intelligent instruments based upon a general purpose computer platform. The software is based on an object-oriented programming environment commonly used for artificial intelligence applications. These technologies provide a highly reactive development base which can rapidly develop instruments for any industry. Radiant Systems' initial pursuit is a product for use in hospital operating rooms. The Center has assisted Radiant Systems with business plan development and acquiring capital funds for start-up, development and production.





St. Louis Technology Center— St. Louis, Missouri

The St. Louis Technology Center assists emerging technology-based businesses through a series of programs designed to cut costs, to ease administration, and to develop strategic plans based on market research and technology assessment. Additionally, the Center provides programs for financing, product development assistance, and managerial support.

The Center's clients work in the fields of biotechnology, factory automation, laser technology, health care and life sciences, electronics, hazardous waste management, and computer sciences.

The employment of center clients reached 194 in mid-1989 and is expected to reach 220 by year end. Their aggregate annual payroll of \$3.5 million last year will approach \$6 million this year. This payroll will generate personal income and sales taxes in excess of the financial support provided by the State of Missouri to the Center.

Client sales of \$9.7 million in 1988 was matched in July of 1989 and is expected to total \$16 million for 1989.

To date, over \$18 million of private equity money has been invested in these Missouri businesses, which also have raised over \$2 million in debt financing.

The Technology Center provides a series of programs to its clients that are designed to meet the full range of needs common to new technology-based businesses. In addition to typical business services, the St. Louis Technology Center offers the following:

A. Strategic Planning

The Technology Center assists its clients in the development of their business, marketing, and operational plans through the strategic planning process, which is based on detailed market research and technology assessment conducted through its Business Development Group. This Group is composed of experienced professionals and is staffed by five graduate students. While strategic planning teams that include individuals experienced in product development, marketing, manufacturing and cost analysis are common in industry, the concept is novel to incubators.

B. Access to Financing

In 1989 the Center formed a \$2 million fund to guarantee bank loans to provide working capital for start-up businesses that

need the money to perform on contracts. This Fund was capitalized by the Missouri State Employees Retirement System and was formed in conjunction with the Missouri Corporation for Science and Technology and the Rolla Innovation Center.

The Center is developing a seed capital fund, which is expected to close this year and ultimately reach \$5 million. The Center has developed excellent relationships with area financial institutions, venture funds, and local investor groups, who, to date, have provided the local funding for the Center's clients.

C. Product Development Support

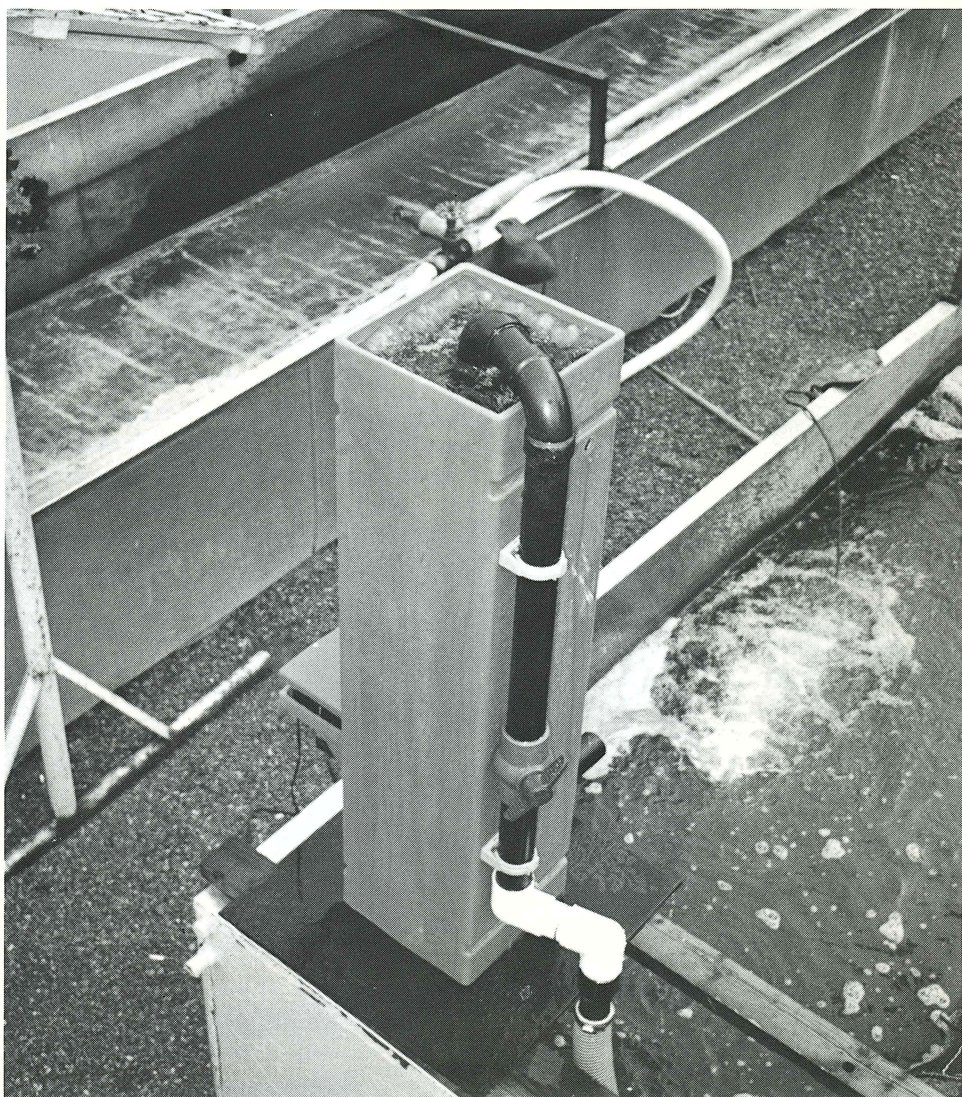
The Center has arranged for substantial product development support for its clients through area universities on an ad hoc basis. This support has included technical assistance, equipment use, personnel support and laboratory use.

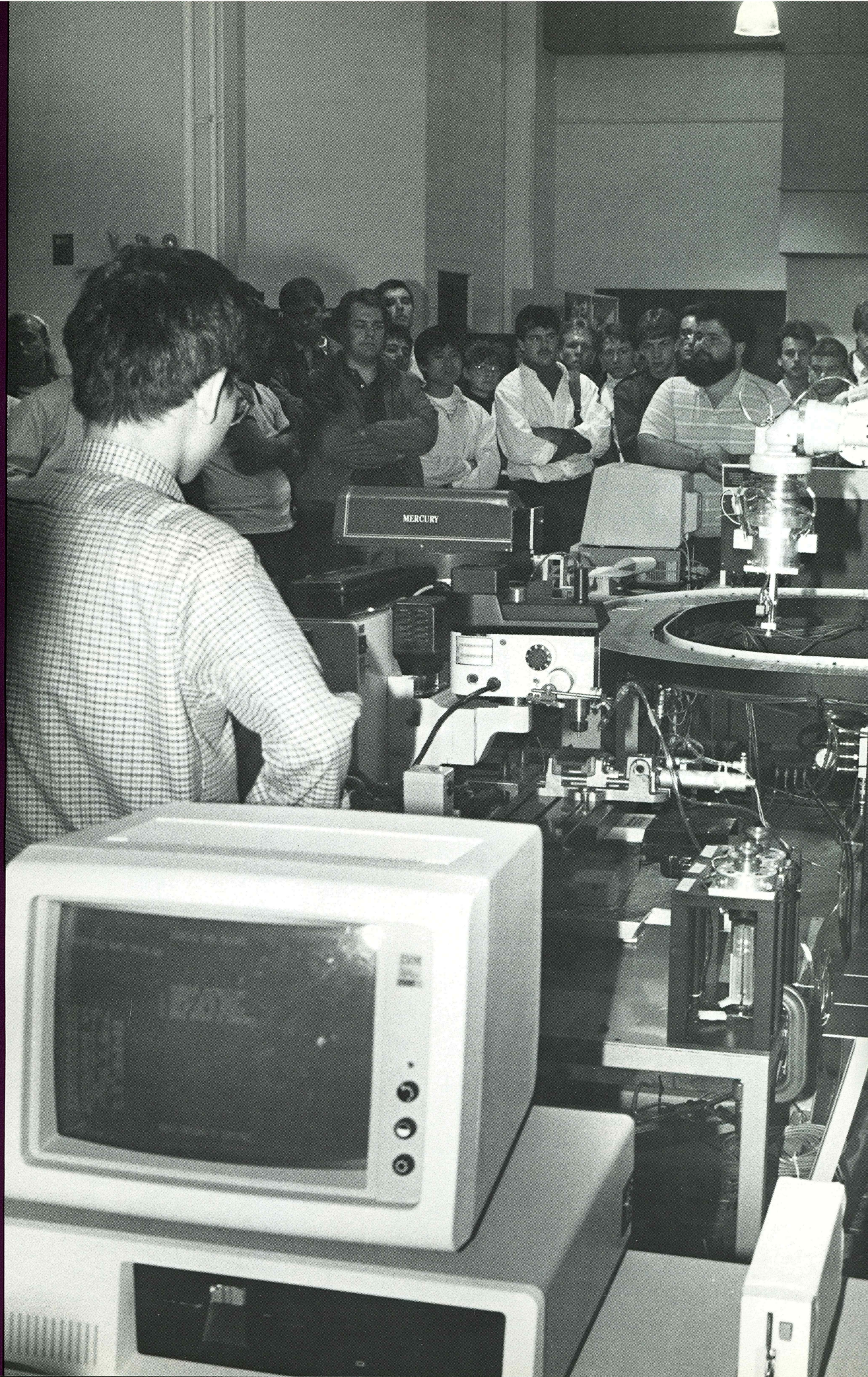
D. Managerial Support

The Center has developed a program

for the delivery of operations management geared toward supporting its clients in the sale of their products during start-up. The St. Louis Technology Center has been instrumental in the successful start-up of several new companies. Its early support of Gold Biotechnology, Incorporated, which produces biological kits for sequencing and cloning of DNA, enabled the company to begin successful marketing of its production. Currently, the company is marketing three products, conducting SBIR-sponsored research while working on additional research in the biotechnology field.

System Integrators, Incorporated is another successful start-up company which evolved at the St. Louis Technology Center. The firm, which develops electronics for medical instrumentation, acoustical signal processing, statistical process control, and micro-miniaturization, is presently expanding and active in designing custom computer systems for industrial process control and statistical analysis.





Missouri Enterprise Business Assistance Center—Rolla, Missouri

The Center at Rolla is administered by the Missouri IncuTech Foundation. During the past twelve months, the center has assisted more businesses than ever before, and broadened its client base to include all parts of Missouri.

Job creation through the use of technology is the primary mission of the center. To accomplish this goal, Missouri Enterprise offers assistance in business planning and support, location of financing, market matching and consulting, and product development.

Missouri Enterprise has made the actual application of existing technology a primary goal. A review of the center's clients reveals that assistance has been provided to a diverse number of Missouri businesses.

The Center's active client list indicates approximately 40 projects now receiving assistance in 24 communities. When combined with projects where our assistance has been completed in the past year, the innovation center's cumulative total represents 91 business clients in almost 40 communities.

The center's best known success resulted from its assistance to Alliance Semiconductor Corporation, which began operation in AT&T's vacant semiconductor manufacturing facility in Lee's Summit. Once in full operation, Alliance Semiconductor is expected to employ 1,200 workers with a payroll of over \$24 million.

Another major success was realized through the center's technical assistance program available to local economic development efforts. After providing the city of Marshfield with consultation regarding refurbishing of a vacant building and assistance in preparation of a financial package and other project elements, Navistar International Transportation Corporation announced plans to open a plant in this location. This leading truck manufacturer, formerly known as International Harvester, will initially hire 30 to 40 employees with plans for expansion.

Missouri Enterprise has become a partner in beginning a new loan guarantee fund. The Missouri Venture Partners Guaranty Fund will provide up to 100% guarantees on commercial loans financing the capital needed by new businesses to fulfill specific sales contracts.

Missouri Enterprise contributed \$100,000 of tax credits available through

the qualified seed capital program toward the \$2 million Guaranty Fund. This contribution has been combined with a previous commitment of \$1,250,769 in credits used for the Alliance Semiconductor project.

During 1990, job creation through the use of technology will continue to be a major emphasis. Other major objectives have been identified.

They include: 1) utilization of new technologies to assist communities with problems in infrastructure maintenance and solid waste reduction; 2) start-up of a flexible, state-of-the-art metal machining facility; 3) improving educational systems resulting in an increased emphasis on math, science, and technology for rural students; and 4) investments resulting in a higher degree of self-sufficiency for the center and independence from state allocations.

In addition to the Missouri Department of Economic Development, the Rolla Center is working with larger numbers of city managers, university extension representatives, county commissions, chambers of commerce, regional planning commissions, and professional and volunteer economic developers in order to make its services and expertise available to more diverse business interests.

Missouri Ingenuity, Incorporated—Columbia, Missouri

Missouri Ingenuity (MI) is guided by a Board of Directors comprised of members from the local business community and the University of Missouri-Columbia in conjunction with its Executive Director. All of the board members and the staff of the Center are diligently pursuing the mission of Missouri Ingenuity, which is technology transfer from the entrepreneurs of the University and the private sector to a commercial reality. The Center styles itself as a "venture assist corporation."

MI specializes in product development and business planning/evaluation for new projects at the "start-up" phase. To accomplish this, the Center employs and networks necessary business and technical specialists to properly prepare the entrepreneur for the real world of commercialization. MI utilizes the resources of the University of Missouri-Columbia campus for prototype development, product enhancement and research.

The Center has incubator office space for critical project activities, and is actively pursuing the establishment of a full-service, technology-based incubator.

Although office space is at a minimum, the Center offers other services that can be utilized by all clients for a minimal fee. Services include, but are not limited to, accounting assistance, business planning, marketing plans, and sourcing of suppliers and manufacturers to produce projects. Another asset of the Center is the clerical support. By utilizing the latest in computer technology and office equipment, MI provides numerous support services such as desk-top publishing, word processing, data base systems, laser printing and the use of a facsimile machine.

Missouri Ingenuity's staff will review in detail any person's business or product that is within the state of Missouri.

The majority of start-up ventures require a significant amount of seed capital. To establish a reliable source of funds, Missouri Ingenuity is structuring a Seed Capital Fund whereby sources of capital may invest in a specific project and obtain special tax benefits.

MI currently has a spectrum of active clients and projects including: high technology radiant heating, aquaculture, agricultural by-products, and specialty electronics. MI's most successful client has developed into a \$2 million operation with 18 employees. In addition, the center has demonstrated its ability to successfully work with the SBIR program.

Innovation Center Performance Statistics

Annual Sales Forecast for All Client Companies	\$35.4 million
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Annual Payroll for All Client Companies	\$12.9 million
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*Total Economic Benefit to the State of Missouri	\$23.5 million
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Missouri employment as a result of projects of client companies	1,051 jobs
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Sources: 1989 Innovation Center Reports

*Missouri Department of Economic Development Tax Benefit Programs



University Research Parks

The state of Missouri is determined to establish a franchise as the "Gateway to the Future" by attracting millions of dollars in private development for the nation's newest university-affiliated research parks in St. Louis and Kansas City.

Missouri Research Park (MRP), a project of the University of Missouri in cooperation with other education institutions in the St. Louis area, offers a campus-like environment on 246 gently rolling, forested acres at the western edge of St. Louis' booming U.S. Highway 40/64 commercial corridor. The park will offer tenants access to university facilities and educational resources, including libraries, information processing, conference facilities, and professional staff and faculty.

The University of Missouri Board of Curators has a contract with Trammell Crow Company, the nation's largest private commercial developer, to manage and develop Missouri Research Park. The developer will concentrate on attracting companies and organizations that can draw on the academic strengths of universities in the St. Louis area, which include such fields as agriculture, computer sciences, robotics, aerospace, medicine, biotechnology and engineering.

Early in the summer of 1987, ground was broken at Missouri Research Park for the installation of roads, utilities and drainage systems. The Missouri General Assembly has appropriated \$4.5 million for construction of infrastructure as part of the first phase of the park's development, which consists of about 105 acres. The installation of infrastructure is now complete, and construction is near completion on a building for the National Weather Service, the Park's first tenant.

Preliminary design work for a University Technology Center at MRP is being developed by the Leo A. Daly architectural firm of St. Louis from planning funds appropriated by the legislature in 1987. The planned center will house support functions for the park, including a MRP management office, a library/resource center, and telecommunication/computer services for the tenants of the park. In the Kansas City area, the University of Missouri at Kansas City, has entered into a joint venture with the Continental Development Group Inc. of New York. This venture will focus on the development of a 68-acre tract of land adjacent to the

campus.

Because of the proximity of research faculty specializing in basic life sciences, pharmacology, telecommunications/computer science and marketing, businesses will be able to be on the "cutting edge" of their respective areas.

Tenants will have access to the video network at UMKC, which features microwave and satellite broadcast capabilities as well as fiber optic lines connecting the four campuses of the University of Missouri.

Final land purchases, relocation and demolition will be completed by spring of 1990. The research park will then be ready to commence construction of the first of 17 buildings to have a total area of two and one half million square feet. Over 5000 employees will be housed in this scenic area located in the heart of Kansas City's country club district.

Centers for Advanced Technology

The Centers for Advanced Technology (CAT) program was established through RSMo. 378.272 in 1986. The objective of this program is to encourage the interaction of Missouri's academic, business, and industrial communities to develop and commercialize new technologies. These partnerships are intended to encourage new innovative technologies, create new businesses, revitalize existing enterprises, and create new jobs in Missouri. The CAT program is based on the view that economic development and growth will result from benefits of academic research and development efforts which are applied to business and industrial problems in a timely and relevant manner. Funds provided under the CAT program are intended to catalyze formation of new, as well as the enhancement of, existing university and business consortia interested in the development and implementation of innovative advanced technology. The CAT program is under the overall guidance of the Missouri Department of Economic Development. Advice on the program is provided by the Missouri Corporation for Science and Technology.

Center for Plant Science and Biotechnology—Washington University, St. Louis, Missouri; The University of Missouri-Columbia; The Missouri Botanical Garden, St. Louis

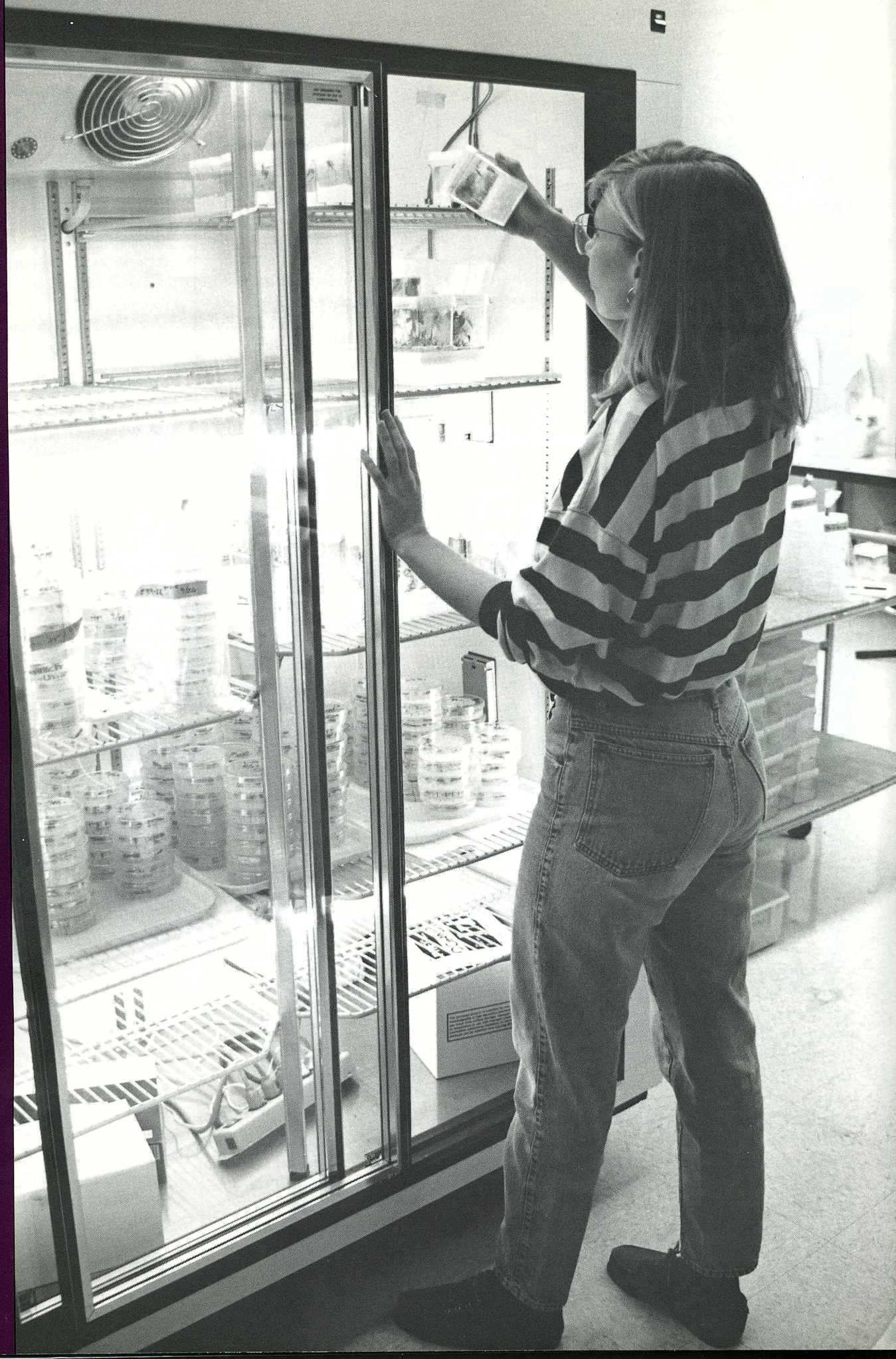
The Center for Plant Science and Biotechnology, located on the campus of

Washington University, is a cooperative effort among Washington University, the University of Missouri at Columbia, and the Missouri Botanical Garden. Research being conducted at the Center is designed to develop new and more disease-resistant crop plants. The nine projects currently in progress at the center include new plant genes, increasing the yield of soybeans, and the effect of drought conditions on various species of plants. Of particular significance are those projects which have the potential for commercialization.

The development of the internationally recognized plant biotechnology program at Washington University is due in large part to the efforts and successes of the research group along with their collaborators at the Monsanto Company in St. Louis. With the support of Monsanto, Washington University scientists were co-inventors of a novel mechanism for making plants resistant to virus attack. This invention, for which patents have been applied, is one of the first real opportunities for the application of biotechnology to agriculture. The co-discovery of this novel mechanism for developing virus resistant plants has led to an increase in grant funds to Washington University and an increase in research staff at Monsanto Company. Approximately ten scientists are funded for research projects at Washington University from funding sources outside of Missouri, including the Government of France, the Rockefeller Foundation, and the National Institutes of Health.

Several new business ventures may develop out of the discovery made by scientists at Washington University and Monsanto. These opportunities revolve around genetic transformation to produce virus disease resistance in ornamental, forage and food crops.

A modified particle gun was developed in the instrument shop in the Biology Department at Washington University. The gun is used to introduce novel genes into plants. One of the guns produced by the shop will be used at Washington University and a second has been donated to the University of Missouri at Columbia. Several of the center's staff are considering starting a business to manufacture and market the modified particle gun for transfer of DNA to plant cells. The demand for particle guns has increased dramatically as scientists in academic and industrial research laboratories have recognized the potential of these instruments to introduce new genes into cells.



**Center for Advanced
Technology in
Telecommunications and
Computer Networking—
University of Missouri, Kansas City**

The Center for Advanced Technology (CAT) in Telecommunications and Computer Networking is located on the campus of the University of Missouri at Kansas City. Companies that include AT&T, Southwestern Bell, United Telecom, and U.S. Sprint encouraged the University of Missouri-Kansas City to establish this center. It provides a unique opportunity for the consortium of university and businesses to work together by blending computer science disciplines with the equipment and media capabilities which exist on the University campus. There are more than 80 courses being offered through this program, 40 of which are at the graduate level. There have been six projects brought into this center during the past fiscal year. Three additional research projects are to be added during fiscal year 1990.

CAT scientists conduct research in areas of general interest to the telecommunications and computer networking industry. Among these are the investigation of integrated digital networks. They will study the fundamental design mathematics associated with voice and data networks in an attempt to unify the mathematical definition of "integrated digital networks," which are indiscriminate to voice and data. Another project involves the continued development of a full-text, online information service containing the current literature in the fields of telecommunications and computer networking. Not only is effort needed to identify appropriate sources of this information, but significant effort will also be required to customize the software on which to run the service for CAT members. Several members of the CAT research team are exploring the development of new proposals for generic research, preparing research proposals to government and private agencies, soliciting additional Consortium members and developing linkages with appropriate economic development agencies and educational institutions. Besides noted scientists in telecommunications and computer networking, the faculty includes prominent experts in artificial intelligence, in database design and development, in software engineering and in other academic and research specialties in cooperation with

experts in other academic institutions across the nation.

**Missouri Manufacturing
Research and Training Center—
University of Missouri, Rolla, Missouri**

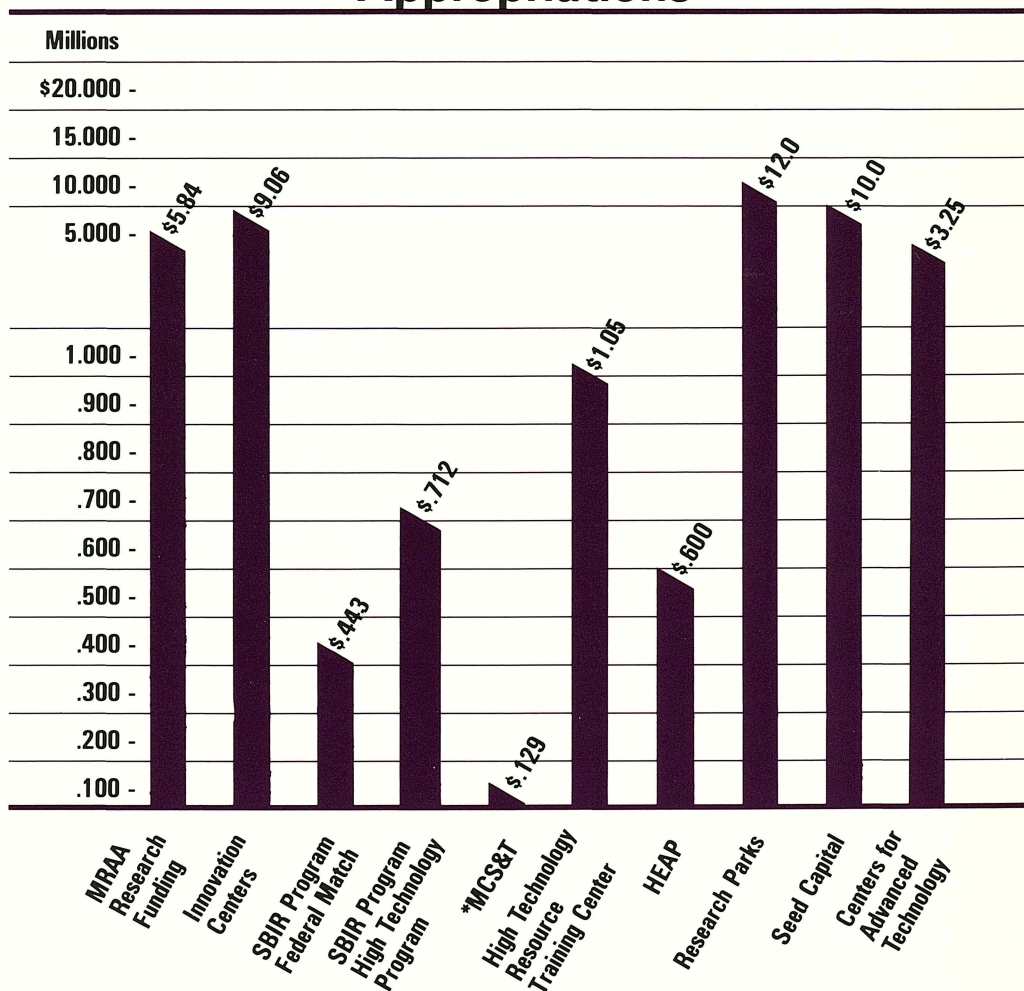
The Manufacturing Research and Training Center is located on the campus of the University of Missouri at Rolla. The objectives of this center are to conduct research and development activities related to manufacturing while assisting in the assessment and transfer of manufacturing technology to Missouri industry. In addition, the center will provide hands-on laboratory instruction using state of the art manufacturing equipment.

Presently there are twenty projects under way within the center. Efforts are concentrated on new product or process development. Work within the Intelligent Systems Center includes projects in artificial intelligence, sensor technology, flexible manufacturing, and the development of new manufacturing techniques. Research in the Materials Research Center includes biomaterials, ceramics, composites ion-implantation polymers as well as significant research in metals and metal adaptation. The Computer Integrated Manufacturing Center researches opportunities for Computer-Aided-Design and Computer-Aided Manufacturing. Flexible manufacturing cells include the latest robotic equipment, which is utilized in a variety of applications.





Missouri Technology Assistance Programs Appropriations



*MCS&T receives only private donations. The corporation had a cash balance on December 31, 1989, of \$73,700.53.

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